PLUG POWER FUEL CELL DEMONSTRATION PROJECT AT THE WATERVLIET ARSENAL

Midpoint Project Status Report

Prepared for

THE CONSTRUCTION ENGINEERING RESEARCH LABORATORY
Champaign, Illinois

Franklin H. Holcomb
Project Manager

Prepared by

PLUG POWER INC.
Latham, New York

Brian C. Davenport
Project Manager

In accordance with Agreement Number:
DACA42-01-C-0053

Overview

This report shall serve as the midpoint project status update for the CERL fuel cell demonstration program pursuant to DACA42-01-C-0053 at the Watervliet Arsenal. Topics covered will include documentation of the installation process including completed site photos, documentation of the acceptance testing as well as performance data review through June of 2002.

Objectives

The installation and operation of PEM fuel cells designed and manufactured by Plug Power at the Watervliet Arsenal, Watervliet, NY has objectives that further the missions of both the U.S. Army Corps of Engineers and Plug Power. The following points summarize the common high-level objectives for this program:

- Allow assessment of fuel cells in supporting sustainable military installations;
- Increase the Army's ability to more efficiently construct, operate and maintain its installations;
- Assess the role of PEM fuel cells in supporting the Army's training, readiness, mobilization, and sustainability missions;
- Provide a technology demonstration site for military base market;
- Provide operational testing & validation of product to assess installation, grid interconnection, operation of systems in all seasonal conditions, and integration of units into an existing military base environment.

Plug Power, a New York State designer and manufacturer of Proton Exchange Membrane (PEM) fuel cells has extensive experience in the design and operation of PEM fuel cell systems since its inception in 1997. Plug's focus on natural gas powered fuel cell systems has resulted in the successful demonstration of systems with increasing reliability, reduced cost, and increasing functionality. Plug Power fuel cells have been sold to, and operated for New York State Energy Research and Development Authority, General Electric, DTE Energy Technologies, and the Long Island Power Authority. In addition, Plug Power has operating experience of integrated fuel cell systems exceeding 225,000 hours in laboratory, field demonstration, and prototypical environmental applications. Plug Power's initial approach to the marketplace is targeting electric and gas utility customers as well as government customers. This program supports Plug Power's recognition of the Department of Defense as a potentially significant customer for fuel cells in the future, and provides the opportunity for an initial assessment of the use of PEM fuel cells supporting military base infrastructure.

Equipment

Plug Power installed and commissioned ten natural gas fuel cell power systems at three separate sites within the Watervliet Arsenal facility. Product specifications for the fuel cells installed are shown in Table 1. The locations selected for installation support residential as well as

operational facilities on the post. The fuel cell systems operate in electric-only, grid-parallel mode using natural gas as a fuel.

Table 1: Product Specifications

Comment	Specification
Unit Size	Base Unit with integral skid: 84.5"L x 32"W x 68"H (excludes 22" exhaust stack)
Installation Location	Outdoor
Grid Parallel	Yes
Power Output/Set points	2.5kW, 4 kW, 5 kW
Remote monitoring capability	Via phone line
Output Voltage	120 / 240 VAC @ 60 Hz
Certification	Integrated System CSA International Listed; Inverter UL Listed
Power Quality	IEEE 519 or better
Emissions (steady-state)	NOx < 5 ppm Sox < 1 ppm CO < 50 ppm
Standard operating conditions	Temperature: O °F to 104 °F Elevation: up to 6,000 ft Noise: < 70 dBA @ 1 meter
Production Schedule	Systems would be manufactured between June, 2001 and October, 2001

Installation

Plug Power worked with CERL and Arsenal personnel to choose the three sites. Each site was selected to match the power output of the fuel cell systems with the electrical demand of the facility being supported. When the site preparation was completed, Plug Power was able to demonstrate a one-day turn around for fuel cell shipment, installation and commissioning.

The following is a summary of the major installation activities:

- **December 17, 2001:** Site preparation commenced.
- **January 7, 2002:** Site preparation complete. This included all foundation work, gas piping, water system installation, electrical interconnection, communications wiring and other work necessary to prepare the sites for the installation and operation of the fuel cell systems.

- **January 15, 2002:** Four (4) systems for Quarters 19 were shipped, installed and commissioned (Figures 2 and 3). "Quarters 19" is an historic building at the Arsenal converted to house four families. One System was installed per housing unit electrical service. Systems B95, B96, B97 and B98 were installed at Quarters 19.

Figure 2:

Figure 3:

- **January 16, 2002:** Three (3) systems for Building 110 were shipped, installed and commissioned (Figures 4 and 5). "Building 110" is a heavy machining facility that houses a telecommunications room for the Arsenal. The Systems were installed to support the telecommunications equipment. Systems B100, B102 and B103 were installed at Building 110.

Figure 4:

Figure 5:

- **January 17, 2002:** Three (3) systems for Building 115 were shipped, installed and commissioned (Figures 6 and 7). "Building 115" is a laboratory facility and the three systems were installed to support destructive testing in the lab. Systems B104, B105 and B106 were installed at Building 115.

Figure 6:

Figure 7:

Acceptance Test Documentation

System Serial Num	Site Description	Delivery Date	Installation Date	Commission Date	Install Checklist	Commission Test	Installer Name
SU01B000000095	Building 19	1/15/02	1/15/02	1/16/02	Complete	Pass	Mike Mezz
SU01B000000096	Building 19	1/15/02	1/15/02	1/16/02	Complete	Pass	Bob Manning
SU01B000000097	Building 19	1/15/02	1/15/02	1/16/02	Complete	Pass	Jon Kinsey
SU01B000000098	Building 19	1/15/02	1/15/02	1/16/02	Complete	Pass	Jan Morawski
SU01B000000100	Building B110	1/16/02	1/16/02	1/17/02	Complete	Pass	Dave Seibert
SU01B000000102	Building B110	1/16/02	1/16/02	1/17/02	Complete	Pass	Vinny Cassala
SU01B000000103	Building B110	1/16/02	1/16/02	1/17/02	Complete	Pass	Mike Mezz
SU01B000000104	Building B115	1/17/02	1/17/02	1/18/02	Complete	Pass	Dave Seibert
SU01B000000105	Building B115	1/17/02	1/17/02	1/21/02	Complete	Pass	Jan Morawski
SU01B000000106	Building B115	1/17/02	1/17/02	1/18/02	Complete	Pass	Vinny Cassala

Performance Data

System #	Site Name	Commission Date	Month of Operation (2002)	Total Run Time (Hours)	Time Period (Hours)	Availability (%)	Total Energy Produced (kWe-hrs)	Average Output (kW)	Capcity Factor (%)	Total Natural Gas Usage (MMBTU's)	Electrical Efficiency (%)
B95	Quarters 19	1/16/02	January	276	374	73.8%	679	2.46	49.2%	9.38	24.7%
			February	672	672	100.0%	1697	2.53	50.5%	21.93	26.4%
			March	699	744	94.0%	1656	2.37	47.4%	22.60	25.0%
			April	701	720	97.4%	1737	2.48	49.6%	24.70	24.0%
			May	718	744	96.5%	1789	2.49	49.8%	25.00	24.4%
			June	716	720	99.4%	1643	2.29	45.9%	28.90	19.4%
			6-month Total	3782	3974	95.2%	9201	2.43	48.7%	132.51	23.7%
B96	Quarters 19	1/16/02	January	377	391	96.4%	954	2.53	50.6%	12.01	27.1%
			February	662	672	98.5%	1718	2.60	51.9%	21.83	26.9%
			March	639	744	85.9%	1577	2.47	49.4%	20.80	25.9%
			April	699	720	97.1%	1734	2.48	49.6%	24.10	24.6%
			May	724	744	97.3%	1869	2.58	51.6%	28.60	22.3%
			June	707	720	98.2%	1787	2.53	50.6%	24.70	24.7%
			6-month Total	3808	3991	95.4%	9639	2.53	50.6%	132.04	24.9%
B97	Quarters 19	1/16/02	January	323	325	99.4%	827	2.56	51.2%	10.48	26.9%
			February	662	672	98.5%	1674	2.53	50.6%	22.81	25.0%
			March	688	744	92.5%	1727	2.51	50.2%	24.40	24.2%
			April	660	720	91.7%	1663	2.52	50.4%	23.00	24.7%
			May	721	744	96.9%	1827	2.53	50.7%	25.60	24.4%
			June	686	720	95.3%	1731	2.52	50.5%	27.10	21.8%
			6-month Total	3740	3925	95.3%	9449	2.53	50.5%	133.39	24.2%
B98	Quarters 19	1/16/02	January	354	368	96.2%	886	2.50	50.1%	11.26	26.8%
			February	595	672	88.5%	1530	2.57	51.4%	19.11	27.3%
			March	715	744	96.1%	1788	2.50	50.0%	22.60	27.0%
			April	717	720	99.6%	1814	2.53	50.6%	23.00	26.9%
			May	727	744	97.7%	1855	2.55	51.0%	24.00	26.4%
			June	720	720	100.0%	1901	2.64	52.8%	26.50	24.5%
			6-month Total	3828	3968	96.5%	9774	2.55	51.1%	126.47	26.4%
B100	Bldg. 115	1/17/02	January	254	317	80.1%	553	2.18	43.5%	7.64	24.7%
			February	672	672	100.0%	1712	2.55	51.0%	20.57	28.4%
			March	744	744	100.0%	1867	2.51	50.2%	22.60	28.2%
			April	582	720	80.8%	1417	2.43	48.7%	19.80	24.4%
			May	681	744	91.5%	1690	2.48	49.6%	21.70	26.6%
			June	712	720	98.9%	2300	3.23	64.6%	30.50	25.7%
			6-month Total	3645	3917	93.1%	9539	2.62	52.3%	122.81	26.5%
B102	Bldg. 115	1/17/02	January	334	336	99.4%	857	2.57	51.3%	11.03	26.5%
			February	662	672	98.5%	1691	2.55	51.1%	21.07	27.4%
			March	744	744	100.0%	1875	2.52	50.4%	24.10	26.5%
			April	656	720	91.1%	1638	2.50	49.9%	21.80	25.6%
			May	655	744	88.0%	1636	2.50	50.0%	23.00	24.3%
			June	695	720	96.5%	2336	3.36	67.2%	31.50	25.3%
			6-month Total	3746	3936	95.2%	10033	2.68	53.6%	132.50	25.8%
B103	Bldg. 115	1/17/02	January	299	324	92.3%	759	2.54	50.8%	9.63	26.9%
			February	631	672	93.9%	1635	2.59	51.8%	20.35	27.4%
			March	744	744	100.0%	1867	2.51	50.2%	22.40	28.4%
			April	700	720	97.2%	1758	2.51	50.2%	22.50	26.7%
			May	744	744	100.0%	1879	2.53	50.5%	23.00	27.9%
			June	716	720	99.4%	2545	3.55	71.1%	35.20	24.7%
			6-month Total	3834	3924	97.7%	10443	2.72	54.5%	133.08	26.8%
B104	Bldg. 110	1/18/02	January	314	324	96.9%	795	2.53	50.6%	10.08	26.9%
			February	672	672	100.0%	1705	2.54	50.7%	21.31	27.3%
			March	744	744	100.0%	1882	2.53	50.6%	24.00	26.8%
			April	707	720	98.2%	1784	2.52	50.5%	22.90	26.6%
			May	723	744	97.2%	1813	2.51	50.2%	24.40	25.4%
			June	720	720	100.0%	1785	2.48	49.6%	23.60	25.8%
			6-month Total	3880	3924	98.9%	9764	2.52	50.3%	126.29	26.4%
B105	Bldg. 110	1/21/02	January	235	249	94.4%	625	2.66	53.2%	7.93	26.9%
			February	672	672	100.0%	1791	2.67	53.3%	22.33	27.4%
			March	684	744	91.9%	1785	2.61	52.2%	23.30	26.1%
			April	720	720	100.0%	1869	2.60	51.9%	24.90	25.6%
			May	744	744	100.0%	1953	2.63	52.5%	28.50	23.4%
			June	652	720	90.6%	1903	2.92	58.4%	27.80	23.4%
			6-month Total	3707	3849	96.3%	9926	2.68	53.6%	134.76	25.1%
B106	Bldg. 110	1/18/02	January	317	336	94.3%	729	2.30	46.0%	9.94	25.0%
			February	650	672	96.7%	1643	2.53	50.6%	20.74	27.0%
			March	744	744	100.0%	1875	2.52	50.4%	24.70	25.9%
			April	694	720	96.4%	1776	2.56	51.2%	25.00	24.2%
			May	689	744	92.6%	1773	2.57	51.5%	24.60	24.6%
			June	654	720	90.8%	1869	2.86	57.2%	26.70	23.9%
			6-month Total	3748	3936	95.2%	9665	2.58	51.6%	131.68	25.0%
			Fleet 6-month Total	**37718**	**39344**	**95.9%**	**97433**	**2.58**	**51.7%**	**1305.53**	**25.5%**

Points of Contact

Plug Power, Inc.
Scott Wilshire, Director of Product Applications
(518) 782-7700 x1338
scott_wilshire@plugpower.com

Gerard Conway, Director of Government Relations
(518) 782-7700 x1970
gerard_conway@plugpower.com

Brian Davenport, Market Engagement Manager
(518) 782-7700 x1939
brian_davenport@plugpower.com

Watervliet Arsenal
Vanessa Duenas
(518) 266-3672
duenas@wva.army.mil